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The UK military experience of thoracic injury in the wars in Iraq and Afghanistan[☆]

H. Poon [a,b,*], J.J. Morrison [a,c], A.N. Apodaca [d], M.A. Khan [a,e], J.P. Garner [f,a]

[a] Academic Department of Military Surgery and Trauma (ADMST), Royal Centre for Defence Medicine, Birmingham, United Kingdom
[b] Queen Elizabeth Hospital Birmingham, United Kingdom
[c] Army Institute of Surgical Research, Fort Sam Houston, San Antonio, TX, USA
[d] Joint Trauma System (JTS), US Army Institute of Surgical Research (ISR), Fort Sam Houston, San Antonio, TX, USA
[e] R Adams Cowley Shock Trauma Centre, Baltimore, MD, USA
[f] Rotherham NHS Foundation Trust, United Kingdom

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ABSTRACT

Introduction: Thoracic injury during warfare is associated with a high incidence of morbidity and mortality. This study examines the pattern and mortality of thoracic wounding in the counter-insurgency conflicts of Iraq and Afghanistan, and outlines the operative and decision making skills required by the modern military surgeon in the deployed hospital setting to manage these injuries.
Methods: The UK Joint Theatre Trauma Registry was searched between 2003 and 2011 to identify all patients who sustained battle-related thoracic injuries admitted to a UK Field Hospital (Role 3). All UK soldiers, coalition forces and local civilians were included.
Results: During the study period 7856 patients were admitted because of trauma, 826 (10.5%) of whom had thoracic injury. Thoracic injury-related mortality was 118/826 (14.3%). There were no differences in gender, age, coalition status and mechanism of injury between survivors and non-survivors. Survivors had a significantly higher GCS, Revised Trauma Score and systolic blood pressure on admission to a Role 3 facility. Multivariable regression analysis identified admission systolic blood pressure less than 90, severe head or abdominal injury and cardiac arrest as independent predictors of mortality.
Conclusions: Blast is the main mechanism of thoracic wounding in the recent conflicts in Iraq and Afghanistan. Thoracic trauma in association with severe head or abdominal injuries are predictors of mortality, rather than thoracic injury alone. Deploying surgeons require training in thoracic surgery in order to be able to manage patients appropriately at Role 3.

Introduction

Thoracic injury during warfare is associated with a high incidence of morbidity and mortality. In World War I, chest injuries were 6% of all combat wounds,[1] with a mortality of 24–27%[2]; haemorrhage and empyema were the leading causes of death. Surgical intervention was largely limited to tube thoracostomy, with few thoracotomies being performed, as patients often arrived at the hospitals in haemorrhagic shock and unfit for surgery.[3] During the Second World War, the overall mortality from thoracic trauma had reduced to 9–11%[4] with developments such as endotracheal intubation, mechanical ventilation, the use of antimicrobial agents and improved pulmonary toilet techniques removing retained clots and contamination.[5] In Vietnam, thoracic injury mortality fell further to 2.9%,[6] with the reduction attributable to rapid evacuation rather than advances in surgical technique.[4] Haemorrhage and sepsis have remained the main causes of mortality throughout twentieth century warfare.[1,6]

In the recent conflicts in Iraq and Afghanistan, conventional ballistic warfare has given way to counter-insurgency campaigns, characterized by widespread use of Improvised Explosive Devices (IEDs).[7] Casualties maimed by such devices present with multiple injuries, contaminated wounds and significant blood loss.[8] The UK Defence Medical Services (DMS) has introduced Damage Control Resuscitation (DCR) to deliver an end-to-end trauma system incorporating rapid evacuation, early haemostatic resuscitation and damage control surgery designed to reduce battlefield mortality.[9] Current wartime literature concentrates on lower extremity and pelvic injury patterns in the era of IEDs,[10] it remains unclear whether the pattern of thoracic injury and its outcomes, within the context of modern battlefield evacuation and resuscitation, have changed.

This study examines the pattern and mortality of thoracic wounding in the counter-insurgency conflicts of Iraq and Afghanistan, and outlines the operative and decision making skills

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* Corresponding author at: Queen Elizabeth Hospital Birmingham, Mindelsohn Way Edgbaston, Birmingham B15 2WB, United Kingdom. Tel.: +44 121 6272000.
E-mail address: hpoonie@doctors.net.uk (H. Poon).

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required by the modern military surgeon in the deployed hospital setting to manage these injuries.

Methods

Permission for this study was granted from the Royal Centre for Defence Medicine (RCDM) Academic Unit. All patients sustaining a combat-related thoracic injury, admitted to a UK Role 3 medical facility (deployed Field Hospital) between March 2003 and March 2011 were identified from the UK Joint Theatre Trauma Registry (JTTR) using body region coding. The UK JJTR is a prospective database recording data on casualties who trigger trauma team activation.[11]

The Roles of medical care describe the echelons and capabilities available for treatment as the casualty is evacuated.[12] A Role 3 facility is a field hospital with a surgical capability, an intensive care unit (ICU), radiological investigations including computed tomography (CT), laboratory and blood bank. A Role 4 hospital is a fixed capability in the home nation capable of providing full National Health Service (NHS) standard of care in all capabilities.

The JTTR was interrogated for data on patient demographics, injury severity and patterns, mechanism of injury, timeline, admission physiology, blood products and surgical procedures. Injury Severity Score (ISS) greater than 15 indicated severe trauma.[13] Blood pressure, respiratory rate and GCS were amalgamated into the Revised Trauma Score (RTS), generating a score inversely proportional to mortality.[14] Injury patterns were classified using the Abbreviated Injury Scale (AIS), with an AIS ≥ 3 3 in a body region indicating serious injury.[15]The RTS and ISS were combined using trauma injury severity scoring (TRISS) methodology which generates a percentage prediction of survival.[16] A surviving patient with a TRISS of 50% or less was considered an unexpected survivor. The proportion of unexpected survivors pre-2009 and post-2009 were compared. The year 2009 was defined as the cut off point in the comparison, because the UK damage control strategy was more formalized from that year onwards.[17]Follow-up varied between two patient categories; Local Nationals (LN) who were discharged from Role 3 in a stable physiological state to local facilities and Coalition Forces entered their countries' respective aeromedical evacuation chains. As follow up data is not available beyond discharge from the UK Role 3 facility, our analysis does not extend beyond Role 3 care.

Patients were categorized as survivors or non-survivors and all statistical analyses performed using SPSS 19 software (IBM®, New York). *T*-tests were used for continuous data, Mann–Whitney rank-sum test for ordinal data and categorical data were analysed using chi-squared test. Univariate comparisons with p values less than 0.25 were entered into a multivariable regression analysis to identify independent predictors of mortality.

Results

Admission characteristics and comparison

Between March 2003 and March 2011, 7856 patients were admitted to UK Role 3 hospitals with battle-related trauma, 826 (10.5%) had sustained thoracic injury. The overall mortality was 426/7856 (5.4%) compared to those with thoracic injury 118/826 (14.3%) and 308/7030 (4.4%) for those without thoracic injury (p value <0.001). There were no differences in gender, age, patient category and mechanism of injury between survivors and non-survivors (Table 1). Blast was the main mechanism of injury amongst our patients.

There was a significant difference in pre-hospital time between survivors and non survivors (Table 2). Survivors had a significantly higher GCS, RTS and systolic blood pressure on admission to a Role 3 facility (Table 2). Non-survivors received significantly more blood products than survivors. The survival group also had a lower median ISS and NISS suggesting a less severe injury burden (Table 3). Non-survivors had a greater proportion of severe head, thorax and abdominal injuries. There was no difference in the incidence of neck wounding (Table 3). There was a significant increase between proportion of unexpected survivors when comparing pre-2009 and post-2009 (3.5% vs. 9.4%; $p = 0.014$) (Fig. 1).

Surgical procedures

Forty-six out of 106 patients who had a thoracotomy died, giving an in-hospital mortality of 45.2%. A higher proportion of non-survivors had thoracotomy alone or concurrent thoracotomy and laparotomy compared to the survivor group, where the majority were managed with non-surgical intervention (Table 4).

Table 1
Demographics of all patients admitted to Role 3 with thoracic injury.

	Survivors ($n = 708$)	Non-survivors ($n = 118$)	P[d]
Demographic data			
Male (%)	673 (95.1)	112 (94.9)	0.948
Female (%)	35 (4.9)	6(5.1)	
Age (years)[a,b]	24.4 (11.2)	25.8 (11.0)	0.291[e]
Patient category			
Coalition (%)	295 (41.7)	47 (39.8)	0.711
LN (%)	413 (58.3)	71 (60.2)	
Mechanism of injury			
Blast	410 (57.9)	67 (56.8)	0.621
GSW	271 (38.3)	49 (41.5)	
Other[c]	23 (3.2)	2 (1.7)	
Unknown	4 (0.6)	0	

[a] Values are mean (standard deviation). Age range 0–80 years.
[b] Missing data in 152 patients. Coalition includes UK, US and other coalition forces; LN, local national includes local civilians and local military forces. GSW: gunshot wound.
[c] Other; stabbing, motor vehicle collision, aircraft incident.
[d] Survivors vs. non-survivors (Chi-squared test, except *t*-test).
[e] *t*-test.

Table 2
Timeline, admission physiology and resuscitation of patients in Role 3.

	Survivors ($n = 708$)	Non-survivors ($n = 118$)	P
Timeline data			
Pre-hospital time (min)	82 (102)	74 (61)	0.033
R3 Stay – all patients (days)	2 (4)	0 (1)	<0.001
R3 Stay – coalition (days)	1 (1)	0 (1)	<0.001
R3 Stay – LN (days)	3.5 (6)	0 (2)	<0.001
Admission physiology			
SBP, mean (SD)	131 (57)	90 (51)	<0.001[c]
SBP <90, n (%)[a]	50 (8)	32 (40)	<0.001[b]
GCS, median (range)	15 (3–15)	3 (3–15)	<0.001[d]
GCS $\leq$ 8, n (%)[a]	101 (17.6)	67 (75.3)	<0.001[b]
Resuscitation in first 24 h			
PRBC	0 (5)	6(13)	<0.001
FFP	0 (4)	5 (12)	<0.001
Cryoprecipitate	0 (0)	0 (1)	<0.001
Platelets	0 (0)	0 (2)	<0.001

Values are median and interquartile ranges in parentheses unless otherwise stated.
[a] Patients numbers with percentages in parentheses. Coalition includes UK, US and other coalition forces; LN, local national includes local civilians and local military forces. GSW, gunshot wound. SD, standard deviation.
[b] Survivors vs. non-survivors (Chi-squared test, except *t*-test, Mann–Whitney rank-sum test).
[c] *t*-test.
[d] Mann–Whitney rank-sum test.

Table 3
Injury pattern and severity of patients admitted to Role 3 (R3) with thoracic injury.

	Survivors (n = 708)	Non-survivors (n = 118)	P[c]
Injury burden			
ISS[a]	17 (1–75)	42 (1–75)	<0.001
ISS >15	354 (50.4)	95 (86.4)	[d]
NISS[a]	17 (1–75)	57 (3–75)	<0.001
NISS >15	424 (60.3)	101 (91.8)	[d]
RTS[a]	7.84 (0–7.84)	4.09 (0–7.84)	<0.001
Injury pattern[b]			
Head	59 (8.2)	39 (33.1)	[d]
Neck	9 (1.3)	2 (1.7)	0.536[d]
Chest	345 (48.7)	75 (63.6)	[d]
Abdominal	81 (11.4)	39 (33.1)	[d]
Upper extremity	53 (7.5)	16 (13.6)	0.004[d]
Lower extremity	110 (15.5)	30 (25.4)	[d]

Values are patient numbers, parentheses percentage unless otherwise stated.
[a] Values in median (range).
[b] Injury Pattern defined as body regions with an AIS ≥ 3. GCS, Glasgow Coma Scale; ISS, Injury Severity Score; NISS, New Injury Severity Score; RTS, Revised Trauma Score; AIS, Abbreviated Injury Scale.
[c] Survivors vs. fatalities (Mann–Whitney rank-sum test p values <0.001 unless otherwise stated).
[d] Survivors vs. fatalities (Chi-squared test p values <0.001 unless otherwise stated).

Overall, left and right anterolateral thoracotomy were equally utilized (28%) followed by the clamshell approach (26.4%). Among the non survivors, the clamshell thoracotomy (47.8%) was the most common approach to the chest. All thoracotomies were performed within 24 h of admission apart from four; which were performed after 24 h of admission for empyema, delayed haemorrhage and two broncho-pleural fistulas in LNs. There was significant difference between survivors and non-survivors in all approaches to the chest (right, left and clamshell thoracotomy and median sternotomy).

Successful trauma pneumonectomies were performed in two patients; an Afghan soldier with an isolated through-and-through gunshot wound (GSW) to the chest and a Coalition soldier with gunshot wound to the right thoraco-abdomen. The Afghan soldier was discharged in a stable physiological and ambulatory state on day 20, having undergone a semi-elective pneumonectomy on Day Three of his admission for a broncho-pleural fistula on a background of massive blast lung. The Coalition soldier had sustained extensive thoraco-abdominal injuries requiring laparotomy, Pringle manoeuvre and liver packing, followed by a right pneumonectomy through a clamshell incision. He was retrieved from Role 3 to Role 4 on an extra-corporeal carbon dioxide removal system,[18] prior to returning to Role 4 facilities.

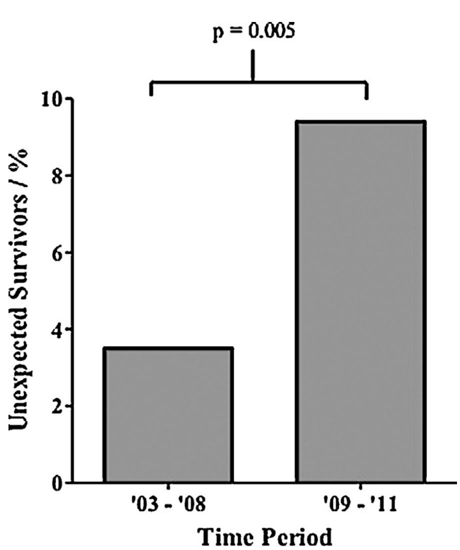

Fig. 1. Bar chart demonstrating the change in percentage of unexpected survivors in compared between 2003–08 and 2009–11.

Nearly two-thirds of the patients who had lobectomies survived; eight patients had non-anatomical resections. None of the patients who had pulmonary tractotomy died. Seven cardiac repairs (two left ventricles, three right ventricles and two right atria) were performed without cardio-pulmonary bypass with six survivors. Six were LN personnel and 2 Coalition soldiers; all except one had fragmentation injuries and one had undergone pre-hospital pericardiocentesis for cardiac tamponade.

Cardiac arrest subgroup analysis

Thirty patients lost cardiac output following injury, requiring open cardiac massage and aortic cross clamping. The median ISS in this subgroup was 38 (range 9–75) and the mechanism of injury was equally distributed between blast and GSW. Two (6.7%) patients survived, one LN injured by GSW and a Coalition patient injured by an IED. Among the twenty-eight non-survivors, eleven (39.3%) had isolated severe thoracic injury, seventeen (60.7%) had severe injury in another body region in additional to the severe thoracic injury; most commonly in the abdominal region (64.7%). Of those with isolated severe thoracic injury, eight patients (72.7%) had penetrating injuries from GSW. Eleven (36.7%) patients had concurrent laparotomy, including the two survivors.

Regression analysis

The following variables were entered into a multivariable regression analysis: cardiac arrest, admission systolic blood pressure <90, AIS head ≥ 3, AIS thorax ≥ 3, AIS abdomen ≥ 3, AIS lower extremity ≥ 3, AIS upper extremity ≥ 3, patient category (LN vs. Coalition) and length of pre-hospital time.

The regression analysis identified the following parameters as independent predictors of mortality: systolic blood pressure <90, severe head and abdominal injuries, cardiac arrest and non coalition casualties (Table 5). Pre-hospital time is not an independent predictor of mortality in our model. Goodness of the logistic regression model fit was demonstrated using a Hosmer and Lemeshow test; $p = 0.566$.

Discussion

This study reports a consecutive series of 826 patients with thoracic injury treated in Role 3 UK military hospitals over the past eight years. Thoracic injuries were 10.5% of all Role 3 battle related admissions; 12.8% of those patients underwent thoracotomy in field hospitals. Blast contributed to 56.8% of the injuries, which fits with the increased use of IEDs in these wars.[7] The proportion of unexpected survivors has increased, suggestive of an overall improvement in military trauma care.[17] This improvement is unlikely to be attributed by a single factor, but symbolizes a mature end-to-end trauma system with early senior involvement in decision making, aggressive damage control resuscitation and the availability of sophisticated facilities.

The mortality of patients with thoracic injury is thrice that of patients without thoracic injury (14.3% vs. 4.4%). However, thoracic trauma, per se, is not an independent predictor of mortality, suggesting that overall injury burden is more important. This is supported by the findings that severe head or abdominal injuries in conjunction with thoracic trauma are independent

Table 4
Surgical procedures performed on thoracic injury patients in Role 3.

	Survivors (n = 708)	Non-survivors (n = 118)	P[c]
Non surgical management	464 (65.5)	39 (33.1)	
Surgical management	244 (34.5)	79 (66.9)	
Thoracotomy alone	36 (14.8)	25 (31.6)	<0.001
Laparotomy alone	184 (75.4)	33 (41.8)	
Concurrent thoracotomy and laparotomy	24 (9.8)	21 (26.6)	
Thoracotomy patients	Survivors (n = 60)	Non-survivors (n = 46)	P[d]
Left thoracotomy	19 (31.7)	13 (28.3)	<0.001
Right thoracotomy	24 (40)	8 (17.4)	
Clamshell thoracotomy	6 (10)	22 (47.8)	
Sternotomy[a]	11 (10.6)	3 (6.5)	
Thoracotomy related interventions	Survivors (n = 88)	Non-survivors (n = 53)	
Cardiac massage & aorta control[e]	2 (2.3)	28 (52.8)	
Pneumectomy[e]	2 (2.3)	0 (0)	
Lobectomy[e,b]	10 (11.4)	6 (11.3)	
Tractotomy[e]	4 (4.5)	0 (0)	
Cardiac repair[e]	6 (6.8)	1 (1.9)	
Vascular repair[e]	9 (10.3)	7 (13.2)	
Chest wall haemastasis[e]	8 (9.1)	2 (3.8)	
Removal of fragments[e]	8 (9.1)	1 (1.9)	
Debridement and washout[e]	26 (29.5)	3 (5.7)	
Diaphragmatic repairs	6 (6.8)	0 (0)	
Pericardial window[e]	4 (4.5)	3 (5.7)	
Repair of trachea/bronchus[e]	3 (3.4)	1 (1.9)	
Proximal control neck	0 (0)	1(1.9)	

Values in parentheses are percentages.
[a] Sternotomy includes 1 trapdoor sternotomy survivor.
[b] Lobectomy includes non-anatomical resections.
[c] Non-survivors vs. survivors (Chi-squared test).
[d] Comparison of thoracotomy incision between non-survivors and survivors (Chi-squared test).
[e] Multiple procedures are allowed for.

predictors of mortality. Our model also demonstrated that cardiac arrest as an independent predictor of death, congruent to the prospective observational findings by Tarmey et al.[19] 8% of patients who lost cardiac output survived to discharge.

Pre-morbid health appears to play an important role in outcome. The independent effect of patient category (i.e.: Coalition vs. LN) suggests that Coalition military patients had better outcomes that LN patients with thoracic wounding. This likely relates to the differences in populations: Coalition personnel are medically pre-screened, at a high level of physical fitness, in contrast to LN's, which includes non-military personnel, with all spectrums of age and co-morbidity. It is important to note that all patients admitted to Defence Medical Service facilities are treated with the same high standard of care.[20]

A further important finding is that pre-hospital time did not appear to influence mortality. Trunkey[21] described the classic tri-modal distribution of death after trauma almost thirty years ago; the first and highest peak occur within the first hour, followed by the second peak of death within 1–4 h of injury. Over the past decade, several studies from mature level 1 trauma centres have been unable to reproduce Trunkey's results, but have demonstrated that mechanism of injury and trauma burden play a greater role in determining the distribution of death.[22,23] Our median event to hospital time in this cohort was 80 min; this is consistent with a study by McLeod et al.[24] that the military pre-hospital timeline is comparative to civilian data.

In the subgroup analysis of patients who had traumatic cardiac arrest requiring aortic cross clamping and cardiac massage, there were 2 survivors (6.7%) which is comparable to the generally poor survival rates reported in the civilian literature.[25] GSW and blast contributed equally as the mechanism of wounding in both survivors and non-survivors.

Retrospective registry studies in conflict have innate limitations. The UK JTTR is designed as a performance improvement tool, and thus is not a complete clinical record of care[11]; however, it does capture treatments and outcomes prospectively. We are unable to accurately interpret the decision making process for intervention with thoracotomy by surgeons from the JTTR. Unfortunately, data capture, in the case of LN and non-UK coalition military personnel, stops upon discharge and are only we are only able to report in-hospital mortality. All LN are discharged in a stable physiological state as part of good practice and ethical care; thus we believe the hidden mortality is minimal. It is possible that in some circumstances, the desire to do everything possible' for a severely injured soldier may have resulted in thoracotomies outside of the resuscitative thoracotomy guidelines, but this is impossible to ascertain from our data.

Table 5
Multivariable logistic regression analysis results of variables associated with mortality in patients with thoracic injury.

	Odd ratio (95% CI)	P
Systolic blood pressure<90	4.89 (1.99–12.00)	0.001
Severe head injury	12.87 (5.88–28.15)	<0.001
Severe thoracic injury	1.05 (0.52–2.14)	0.884
Severe abdominal injury	5.36 (2.41–11.96)	<0.001
Severe upper extremity injury	1.49 (0.47–4.73)	0.498
Severe lower extremity injury	1.30 (0.49–3.43)	0.598
Coalition patient category	0.35 (0.15–0.84)	0.018
Time to ED	1.00 (1.00–1.00)	0.304
Cardiac arrest	106.88 (10.88–1050.06)	<0.001
Hosmer–Lemeshow Test: $\chi^2 = 6.732$, df = 8, $p = 0.566$		

CI: confidence interval. Severe injury defined as abbreviated injury score ≥3.

Secondary blast fragments were the main mechanism of wounding for thoracic injury from the First and Second World Wars[4]; this had not changed in the Korean War where such fragments caused 87% of the thoracic wounds[26] and blast again remains the leading cause of wartime thoracic wounding. Mobile Army Surgical Hospitals were the most forward operating facilities in Korea; 32% of thoracic injury casualties had limited thoracotomy for debridement and washout and 10% had formal thoracotomy, comparable to our thoracotomy rate of 13% although a lesser proportion of our patients had thoracotomy for debridement and washout. In their patient cohort, 23% had thoracoabdominal wounds and the primarily surgical approach taken was through the abdomen. Nearly one third of our patients with thoracic injuries underwent laparotomy, but less than 4% had thoracolaparotomy; unfortunately data regarding which cavity was explored first in these cases is not available.

Civilians make up almost half (49%) of our admissions in contrast to most reports of thoracic injury from the World Wars, Korea and Vietnam, and they represent a range of ages and co-morbidities and an associated variability in outcome. Useful comparison can be made with the data from the Lebanon and Balkans conflicts, which include both military and civilian populations. Zakharia has reported a large personal series of cardiothoracic trauma from a mature hospital system in the Lebanon war[27,28] – one third of casualties were civilian; secondary blast fragmentation generated 57% of injuries and high energy transfer gunshot wounding 42% of wounds As a cardiothoracic surgeon he advocated early thoracotomy, within 90 min of arrival to hospital; 726 thoracotomies were performed within this timeframe, of which 41 patients (5.6%) had no identifiable intra-thoracic bleeding. Half of these required concomitant laparotomy for haemorrhage control, whilst the remainder were managed via the thoracotomy. His overall thoracotomy rate greatly exceeded ours (70% vs. 12.8%).[27] Biocina et al[29] reported a 67% rate of fragmentation injury in the Balkans war with a thoracotomy rate of 53.6%; in comparison other authors reporting from the same conflict[30] primarily advocated conservative management, with a thoracotomy rate of 22.3% and a 2% overall mortality amongst all thoracic trauma patients. These two examples[26,27] highlight the subjective nature of the decision making process for thoracotomy.

In Lebanon, twenty-six cardiac injuries were repaired using inflow occlusion and cardiopulmonary bypass with survival rates of 82% and 44% respectively[31]. Seven of our patients had cardiac repair without cardiopulmonary bypass with six surviving to discharge, although we accept that they are likely to be a self selecting group, as they arrived to Role 3 with spontaneous circulation. In Zakharia's personal series,[28] 36 pneumonectomies were performed; Biocina[29] reported that 5 patients had pneumonectomy. However there was no further information as to whether these patients survived. We report two patients undergoing a trauma pneumonectomy performed by non-cardiothoracic surgeons, both of whom survived. The Coalition patient was ventilated on pumpless interventional extracorporeal lung assist (iLA) in Afghanistan prior transfer by air; the physicians in charge of his care attributed his survival to early implementation of iLA and involvement of the acute lung rescue team.[18]

In the First Gulf War few allied troops were injured; thoracic injuries rates were reported at 12% and all were managed with thoracostomy and local wound excision without the need for thoracotomy.[32] Mabry et al.[33] reported higher rates of penetrating gunshot injuries in the US experience in Somalia compared to Vietnam (55% vs. 30%) although there were less fatal thoracic injuries (14% vs. 39%). This phenomenon was thought to be related to the increased torso protection from combat body armour as most fatal injuries occurred from projectiles entering unprotected regions. Interestingly, despite the use of an improved helmet design, the mortality from penetrating head injuries remained at 36% – the same as in the Vietnam Conflict.[33]

Our results compliment that of Propper et al.[34] in reporting the experience of combat thoracic injury in Iraq and Afghanistan. That US JTTR study reported that half of casualties with thoracic injuries were not wearing combat body armour; however their severity of injuries were less compared to US troops although survival rates were equal. The demographics and mechanism of injury are similar between the US study and our dataset; blast is the most prominent mode of injury and unprotected personnel form a large proportion of our patients as well. Overall median ISS scores were 16 in both series and our thoracotomy rates are similar (12.8% vs. 13.4%); with similar mortality rates from thoracic trauma (14.3% vs. 12.1%).

Within the UK NHS, general surgical trainees have limited exposure to trauma thoracotomy; only a quarter of higher surgical trainees have seen an emergency thoracotomy[35] and Brooks and Ramasamy[35,36] have previously presented data suggesting that a six to eight weeks deployment to the British Military Hospital in Afghanistan is comparable to, or in excess of, the entire trauma experience acquired during higher surgical training. All thoracic surgical interventions detailed in this article were performed by military surgeons who practise as General Surgeons within the NHS. Our dataset confirms the need for all deploying general surgeons to be confident and proficient in operating within the chest and to be able to perform thoracotomy via various approaches and procedures such as pulmonary tractotomy, lung resection, pneumonectomy and cardiac repair on a beating heart, whilst accepting that these are relatively infrequent occurrences.

It is increasingly difficult for NHS general surgical trainees to achieve such skills as most training programmes do not routinely include placements in cardiothoracic surgery. This emphasises the need for formal teaching in these skills prior to a trauma surgery placement, be it civilian or military, and courses such as the Definitive Surgical Trauma Skills (DSTS) in UK[37] or Definite Surgical Trauma Care (DSTC)[38] elsewhere fulfil this role. All deploying military surgeons attend the five day Military Operational Surgical Training (MOST) course – an extended derivative of DSTS – where the faculty are all senior military surgeons who have recently deployed and present contemporaneous trauma experience.

Conclusions

Blast is the main mechanism of thoracic wounding in the recent conflicts in Iraq and Afghanistan. Thoracic trauma with severe head or abdominal injuries on arrival at the Field Hospital are predictors of mortality rather than thoracic injury alone. Time from wounding to arrival at hospital, in this study, does not appear to influence outcome. Deploying surgeons require a wide cardiothoracic skill set in order to manage these injuries effectively in the Role 3 settings and pre-deployment training must meet this requirement.

Conflict of interest statement

The authors have no financial and personal relationships with other people or organisations that could inappropriately influence their work.

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